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Mission Highlights STS-86

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Space cooperation sets international example

Upon returning from his stay aboard Space Station Mir, Astronaut Mike Foale said that the U.S. and Russia's work together in space should be an example to the world, especially its children.

"What we're doing, working together, is gluing countries of the world together." Foale said after his four month stay. "Russia has overcome enormous problems in this last four or five months in space, but not alone, with American help."

"This is an example, not just to our countries, but to others who are participating in our space program and others who might want to in the future, that there are great things for us to do as a planet in space," Foale concluded.

Mission Specialist Jean-Loup Chrétien was exuberant about the performance of the space shuttle and echoed Foale's sentiments about international cooperation.

"*Atlantis* worked perfectly," he said. "…I feel very honored to have been invited to participate in this great mission in which both the United States and Russia have demonstrated to the rest of the world that when two great countries want to do something in a very, very difficult situation, they do it."

Mission Events

The seventh docking mission to the Mir Space Station began with the

Astronaut Scott Parazynski is tethered to a handrail in *Atlantis*' cargo bay.

Space Shuttle *Atlantis*

Sept. 25 – Oct. 6, 1997

Commander:	Jim Wetherbee
Pilot:	Mike Bloomfield
Mission Specialists:	Vladimir Titov
	Scott Parazynski
	Jean-Loup Chrétien
	Wendy Lawrence
	David Wolf (up)
	Mike Foale (down)

Commanders James Wetherbee and Anatoliy Solvyev on *Atlantis*' flight deck.

September 25, 1997, launch of Space Shuttle *Atlantis*. At 9:34 p.m. CDT the seven member crew lifted off from Pad 39A at Kennedy Space Center on a mission to transfer crew and equipment to the orbiting space station.

In addition to the busy transfer activities, the Spacehab module with payload bay experiment packages was activated throughout the flight.

Atlantis docked with Mir on September 27, 1997, at 2:58 p.m. CDT. Less than two hours later, at 4:45 p.m., Commander Jim Wetherbee and Mir Commander Anatoly Solovyev opened their respective spacecraft's hatches to begin six days of joint operations.

During docked operations, Mir's motion control computer was swapped-out prior to a five hour space walk to retrieve four Mir Environmental Effects Packages (MEEPS) which had been mounted on the docking module in March.

Mission Specialists Scott Parazynski and Vladimir Titov began their space walk at 12:29 p.m. CDT, and in addition to the recovery of the MEEPS packages, affixed a 121-pound instrument called a Solar Array Cap to the Docking module for future use by Russian cosmonauts to seal off a suspected breach in the hull of the Spektr Module.

Parazynski and Titov wrapped up their work by testing several components of the Simplified Aid for EVA Rescue (SAFER) jetpacks designed to enable space walkers to propel themselves back to safe haven in the shuttle's payload bay if they become untethered while working.

The two mission specialists ended their space walk at 5:30 p.m. CDT .

After the transfer of more than 1700 pounds of water, hardware for the repair of the damaged Spektr module, a new computer to maintain attitude control for the Russian complex and U.S. astronaut David Wolf, the two commanders closed the hatches between the two spacecraft on October 2, at 5:45 p.m. CDT.

The two craft undocked on October 3, at 12:28 CDT, and the *Atlantis* returned to a Kennedy Space Center landing on October 6, at 4:55 p.m. CDT.

SHUTTLE-MIR ACTIVITIES & SCIENCE

The space walk on STS-86 continued a series of EVA Development Flight Test (EDFT) space walks. EVA participants Parazynski and Titov evaluated equipment designed to be compatible for use by space walkers on the U.S. and Russian segments of the International Space Station. The evaluations included a Universal Foot Restraint designed to hold the boots of both U.S. and Russian space suits; common safety equipment and body restraint tethers; and a common tool carrier.

In addition to retrieving the MEEP, Parazynski and Titov continued an evaluation of the Simplified Aid For EVA Rescue (SAFER), a small jet-backpack designed for use as a type of life jacket during station assembly.

One of the MEEP experiments, The Polished Plate Micrometeoroid and Debris experiment, was designed to study how often space debris hit the station, the sizes of these debris, the source of the debris, and the damage the debris would do if it hit the station.

The Passive Optical Sample Assembly I and II experiments consisted of various materials that were intended for use on the International Space Station. These materials included paint samples, glass coatings, multi-layer insulation and a variety of metallic samples.

The Human Life Sciences (HLS) project was a set of investigations to determine how the body adapts to weightlessness and other space flight factors, including the psychological aspects of a confined environment and how they readapt to Earth's gravitational forces.

The Space Portable Spetroreflectometer (SPSR) was designed to measure the effects of the space environment on spacecraft materials. During Extravehicular Activity (EVA) operations, cosmonauts and astronauts used this device to measure how much energy is absorbed by the thermal control coatings, or radiator surfaces, of the Mir space station. Radiators, which are used to shed excess heat from the spacecraft, play a vital role as part of the station's cooling system.

The SPSR was built for the Space Environments and Effects program at NASA's Marshall Space Flight Center in Huntsville, AL, by AZ Technology, Inc,. of Huntsville.

The Interferometer to study Protein Crystal Growth (IPCG) was designed to yield valuable preliminary data on how protein crystal growth differs in the microgravity environment of space. Researchers also hope to develop technologies and

methods to improve the protein crystal growth process, which could unlock future answers to the molecular structure of targeted proteins, leading to the development of new, disease-fighting drugs. The University of California, Irvine, was the principal investigator of the IPCG experiment.

The Canadian Protein Crystallization Experiment (CAPE) was a biotechnology flight experiment developed by Canadian Space Agency scientists that could help lead to advanced treatment and possible cures for some debilitating diseases, as well as bacterial and viral infections. Some of the diseases targeted include cancer, meningitis, cystic fibrosis, emphysema, diabetes, Alzheimer's, breast cancer and hypertension.

Coordination and integration of the experiment with the Shuttle/Mir Flight Program was managed by NASA's Microgravity Research Program at Marshall Space Flight Center in Huntsville, AL.

The second test of a European laser docking system, sponsored by the European Space Agency (ESA), was performed during the shuttle's approach and departure from Mir. A GPS receiver and an optical rendezvous sensor on the shuttle, together with equipment already installed on Mir, were operated in an enactment of how ESA's unmanned Automated Transfer Vehicle (ATV) will approach and depart the International Space Station.

The Seeds in Space-II (SEEDS-II) experiment passively exposed a group of tomato seeds, in hand-sewn dacron bags, to the vacuum of space. Seeds flown in the SEEDS-II payload were compared with a control group of seeds and an experimental group of seeds located in an underwater habitat in Key Largo, FL. Upon completion of the mission, all of the seeds were distributed to schools for education and outreach purposes. The experiment was designed to increase student awareness of the similarities and complexities involved in the hostile ocean and space environments.

IN-CABIN PAYLOADS

The mission of KidSat was to understand and demonstrate how middle school students could actively make observations of the Earth by using mounted cameras onboard the shuttle to conduct scientific inquiry in support of their middle school curricula. Students engaged in a process to select and analyze images of the Earth during shuttle flights and use the tools of modern science (computers, data analysis tools and the Internet) to widely disseminate the images and results.

The three-year pilot program was a partnership between NASA's Jet Propulsion Laboratory (JPL), the University of California at San Diego (UCSD), and the Johns Hopkins University Institute for the Academic Advancement of Youth (JHU-IAAY). The KidSat pilot program was sponsored by NASA's Office of Human Resources and Education, with support from the Offices of Space Flight, Mission to Planet Earth, and Space Science.

THE COMMERCIAL PROTEIN CRYSTAL GROWTH (CPCG) payload was comprised of a Commercial Refrigerator/Incubator Module (CRIM) designed as a generic carrier, and the Commercial Vapor Diffusion Apparatus (CVDA) experiment. The primary objective of the CVDA experiment is to produce large, high-quality crystals of selected proteins under controlled conditions in microgravity.

THE COSMIC RADIATION EFFECTS AND ACTIVATION MONITOR (CREAM) was used to collect data on cosmic ray energy loss spectra, neutron fluxes and induced radioactivity as a function of geomagnetic coordinates and detector location within the Orbiter. The active monitor was used to obtain real-time spectral data, while the passive monitors obtained data integrated over the mission duration.

THE CELL CULTURE MODULE-A (CCM-A) payload objectives were to validate models for muscle, bone and endothelial cell biochemical and functional loss induced by microgravity stress; to evaluate cytoskeleton, metabolism, membrane integrity and protease activity in target cells; and to test tissue loss pharmaceuticals for efficacy.

THE SHUTTLE IONOSPHERIC MODIFICATION WITH PULSED

The Mir-24 crew in Mir's Base Block. Left to right, Pavel Vinogradov, David Wolf and Anatoly Solovyev.

Mission Specialist Vladimir Titov checks a maze of VHF cables in the Spacehab Module.

LOCAL EXHAUST (SIMPLEX) payload of opportunity had no flight hardware; Orbiter OMS thruster firings were used to create ionospheric disturbances for observation by the SIMPLEX radar. SIMPLEX has three different radar sites used for collecting data: 1) Arecibo, 2) Kwajalein, and 3) Jicamarca. Arecibo used a low-level laser to observe the effects on the ionosphere resulting from the thruster firing.

The objective of the SIMPLEX activity was to determine the source of Very High Frequency (VHF) radar echoes caused by the Orbiter and its OMS engine firings. The principal investigator used the collected data to examine the effects of orbital kinetic energy on ionospheric irregularities and to understand the processes that take place with the venting of exhaust materials.

CREW BIOGRAPHIES

Commander: James D. Wetherbee (CAPT., USN). Wetherbee, 44, was born in Flushing, NY, and received a bachelor of science degree in aerospace engineering from the University of Notre Dame.

Wetherbee became an astronaut in June 1985. He was the pilot on STS-32, which saw the successful deployment of the Syncom IV-F5 satellite, and retrieval of the 21,400-pound Long Duration Exposure Facility (LDEF) using the remote manipulator system (RMS).

Wetherbee was the mission commander on STS-52, which successfully deployed the Laser Geodynamic Satellite (LAGEOS), operated the first U.S. Microgravity Payload (USMP) with French and American experiments, and successfully completed the initial flight tests of the Canadian-built Space Vision System.

He next commanded STS-63 which was the first flight of the new joint Russian-American Space Program. Mission highlights included the rendezvous with the Russian Space Station Mir, operation of Spacehab, and the deployment and retrieval of Spartan 204. A veteran of four space flights, Wetherbee has logged more than 955 hours in space.

Pilot: **Michael J. Bloomfield (Maj, USAF)**. Bloomfield, 38, was born in Flint, MI, and received a bachelor of science degree in engineering mechanics from the U.S. Air Force Academy, and a master of science degree in engineering management from Old Dominion University.

Bloomfield graduated from the USAF Academy in 1981 and completed Undergraduate Pilot Training at Vance Air Force Base. He was selected for the USAF Test Pilot School and honored as a distinguished graduate in 1992. In 1995, he was assigned to NASA as an astronaut candidate.

Bloomfield became an astronaut in 1995 and was initially assigned to work technical issues for the Operations Planning Branch of the Astronaut Office. With the completion of STS-86 he has logged more than 259 hours of space flight.

Mission Specialist: Vladimir Georgievich Titov (Col., RAF) Titov, 50, was born in Sretensk, in the Chita Region of Russia. He graduated from the Higher Air Force College in Chernigov in the Ukraine, and the Yuri Gagarin Air Force Academy.

Titov was selected to join the cosmonaut team and was paired with Gennady Strekalov. Titov and Strekalov were specifically trained to repair the faulty Salyut 7 solar array, but once in orbit the Soyuz rendezvous radar antenna failed to deploy properly.

Titov and Strekalov were then scheduled for launch on board Soyuz T-10 on September 27, 1983. However, a valve in the propellant line failed to close at T-90 seconds, causing a large fire to start at the base of the launch vehicle only one minute before launch. The Soyuz descent module was pulled clear by the launch escape system and the crew landed safely some 2.5 miles (4k m) from the launch vehicle, which apparently exploded seconds later.

As the commander of Soyuz TM-4, Titov linked up with the orbiting Mir 1 space station. Titov returned to Earth with a mission time of more than 365 days.

Titov was a mission specialist on STS-63, the first flight of the new joint Russian-American Space Program. Mission highlights included the rendezvous with the Russian

Space Station Mir, operation of Spacehab, and the deployment and retrieval of Spartan 204. With the completion of STS-86, Titov has logged more than 454 hours in space in U.S. craft, for a total of more than 386 days of space flight.

Mission Specialist: Scott E. Parazynski (MD). Parazynski, 36, was born in Little Rock, AR, and received a bachelor of science degree in biology from Stanford University, continuing on to graduate with honors from Stanford Medical School. He served his medical internship at the Brigham and Women's Hospital of Harvard Medical School. He then completed 22 months of a residency in emergency medicine in Denver, CO.

Parazynski became an astronaut in 1992, and served as one of the crew representatives for extravehicular activity in the Astronaut Office Mission Development Branch. He first flew on STS-66, was assigned as a backup for the third American long-duration stay aboard Russia's Space Station Mir, and was expected to serve as a prime crew member on a subsequent mission. He spent 5 months in training at the Gagarin Cosmonaut Training Center, Star City, Russia. In October 1995, when sitting-height parameters raised concerns about his fitting safely in the Soyuz vehicle in the event of an emergency on-board the Mir station, he was deemed too tall for the mission and was withdrawn from Mir training. With the combination of STS-66 and STS-86, he has logged more than 521 hours in space.

Mission Specialist: Jean-Loup J.M. Chrétien (Brig. Gen., French Air Force). Chrétien, 59, was born in the town of La Rochelle, France. He was educated at L'Ecole communale a Ploujean, the College Saint-Charles a Saint-Brieuc, and the Lycee de Morlaix. He received a masters in aeronautical engineering from L'Ecole de l' Air (the French Air Force Academy) at Salon deProvence.

Chrétien started training at the Yuri Gagarin Cosmonaut Training Center in September 1980. And the following year he was named as the research-cosmonaut for the prime crew of the Soyuz T-6 mission.

Soyuz T-6 was launched on June 24, 1982, and Chrétien, Dzhanibekov and Ivanchenkov linked up with Salyut 7 and joined the crew of Berezovoi and Lebedev already on board. They spent nearly seven days carrying out a program of joint Soviet-French experiments, including a series of French echography cardiovascular monitoring system experiments.

Chrétien's second space flight as a research-cosmonaut was on TM-7. Together with Volkov and Krikalev, he linked up with Mir 1 and joined the crew of Titov Manarov and Polyakov. The 5 hour 57 minute EVA by Volkov and Chrétien on this flight made Chrétien the first non-American and non-Soviet cosmonaut to walk in space.

Chrétien attended ASCAN Training at the Johnson Space Center during 1995. With the completion of STS-86, Chrétien has logged more than 43 days and 10 hours of space flight.

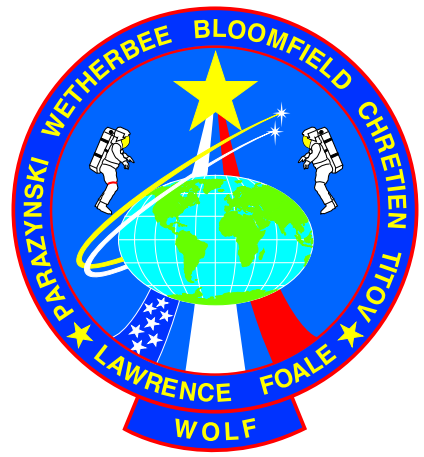
Mission Specialist: Wendy B. Lawrence (Commander, USN). Lawrence, 38, was born in Jacksonville, FL, and received a bachelor of science degree in ocean engineering from the U.S Naval Academy; a master of science degree in ocean engineering from Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution.

Lawrence became an astronaut in 1992, and flew on STS-67 in March 1995. She served as Director of Operations for NASA at the Gagarin Cosmonaut Training Center in Star City, Russia, with responsibility for the coordination and implementation of mission operations activities in the Moscow region for the joint U.S./Russian Shuttle/Mir program. In September 1996, she began training for a 4-month mission on the Russian Space Station Mir, but in July 1997, NASA decided to replace Lawrence with her back-up, Dr. David Wolf. This decision enabled Wolf to act as a backup crew member for space walks planned over the next several months to repair the damaged Spektr module on the Russian outpost. Lawrence also flew with the STS-86 crew

In-Flight portrait: New Mir-24 crew member David Wolf holds a cap at frame right. Clockwise from Wolf are Vladimir Titov, Anatoliy Solovyev, Scott Parazynski, Pavel Vinogradov, James Wetherbee, Wendy Lawrence, Michael Foale, Michael Bloomfield, and Jean-Loup Chrétien.

STS-86
Quick Look

Launch Date:	Sept. 25, 1997
Time:	9:34 pa.m. CDT
Site:	KSC Pad 39A
Orbiter:	*Atlantis* OV-104—20rd flight
Orbit/In.:	160 naut. miles 51.6 degrees
Mission Duration:	10 days, 19 hrs, 21 mns.
Landing Date:	Oct. 6, 1997
Time:	4:55 p.m. CDT
Site:	Kennedy Space Center
Crew:	Jim Wetherbee (CDR) Mike Bloomfield (PLT) Vladimir Titov (MS1) Scott Parazynski (MS2) Jean-Loup Chrétien (MS3) Wendy Lawrence (MS4) David Wolf (MS5 up) Mike Foale (MS5 down)
Shuttle/Mir Activities:	Spacehab, Orbiter Docking System, European Proximity Sensor, MEEP Carriers, SEEDS-II
In-Cabin Payloads:	KidSat, CPCG, CREAM, CCM-A, MSX, SIMPLEX



STS-86 is the seventh Shuttle-Mir docking mission. The international crew includes astronauts from the United States, Russia, and France. The flags of these countries are incorporated in the rays of the astronaut logo. The seven stars represent this seventh mission. The rays of light streaking across the sky depict the orbital tracks of the two spacecraft as they prepare to dock. During the flight an American astronaut and a Russian cosmonaut performed a space walk. The mercator projection of Earth illustrates the global cooperative nature of the flight.

because of her knowledge and experience with Mir systems and with crew transfer logistics for the Mir.

Lawrence flew as the ascent/entry flight engineer and blue shift orbit pilot on STS-67 in March 1995. This mission was the second flight of the ASTRO observatory, a unique complement of three telescopes. During this 16-day mission, the crew conducted observations around the clock to study the far ultraviolet spectra of faint astronomical objects and the polarization of ultraviolet light coming from hot stars and distant galaxies. With the completion of STS-86 Lawrence has logged more than 658 hours of space flight.

Mission Specialist: David A. Wolf (M.D.). Wolf, 41, was born in Indianapolis, IN, and received a bachelor of science degree in electrical engineering from Purdue University, and a doctorate of medicine from Indiana University. He completed his medical internship at Methodist Hospital in Indianapolis, IN, and USAF flight surgeon primary training at Brooks Air Force Base in San Antonio, TX.

In 1983, Wolf joined the Medical Sciences Division at Johnson Space Center. He was responsible for development of the American Flight Echocardiograph for investigating cardiovascular physiology in microgravity. In 1986, he was assigned to direct development of the Space Bioreactor and associated tissue engineering and cancer research applications utilizing controlled gravitational conditions. This resulted in the state of the art NASA rotating tissue culture systems.

Wolf became an astronaut in July 1991, and served as a mission specialist astronaut on STS-58, a 14 day dedicated Spacelab life sciences research mission. During this shuttle mission the crew conducted neurovestibular, cardiovascular, cardiopulmonary, metabolic, and musculoskeletal research utilizing microgravity to reveal fundamental physiology normally masked by earth gravity. At the completion of STS-86, Wolf had logged more than 595 hours of space flight.

Mission Specialist: C. Michael Foale (Ph.D.). Foale, 40, was born in Louth, England, and attended the University of Cambridge, Queens College, receiving a bachelor of arts degree in Physics, National Sciences Tripos, with 1st class honors. While at Queens College, he completed his doctorate in Laboratory Astrophysics at Cambridge University.

Foale became an astronaut in June 1987, and flew as a mission specialist on STS-45 the first of the ATLAS series of missions to address the atmosphere and its interaction with the Sun, and again as a mission specialist on STS-56, carrying ATLAS-2, and the SPARTAN retrievable satellite which made observations of the solar corona. He next served as a mission specialist on STS-63, the first rendezvous with the Russian Space Station, Mir. During the flight he made a 4 hour, 39 minute space walk evaluating the effects of extremely cold conditions on his space suit, as well as moving the 2800-pound Spartan satellite as part of a mass handling experiment. Most recently, Foale was launched on STS-84 which carried him to Mir for a four month stay. With the completion of STS-86, Foale had logged more than 160 days of space flight including 10 1/2 hours of EVA.